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Insights

Making smartphones sustainable: Live long and greener

Lengthening phone lifetimes would help reduce the environmental impact of smartphones. But could smartphone vendors find other revenue sources?

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DELOITTE GLOBAL PREDICTS that smartphones—the world's most popular consumer electronics device, expected to have an installed base of 4.5 billion in 2022[1]—will generate 146 million tons of CO_2 or equivalent emissions (CO_2e) in 2022.[2] This is less than half a percent of the 34 gigatons of total CO_2e emitted globally in 2021, but it is still worth trying to reduce.[3]

The bulk of these emissions, 83% of the total, will come from the manufacture, shipping, and first-year usage of the 1.4 billion new smartphones forecast to be shipped in 2022.[4] Usage-related emissions from the other 3.1 billion smartphones in use during 2022 will generate an additional 11%, and the remainder will come from refurbishing existing smartphones (4%) and end-of-life processes (1%),[5] including recycling.[6]

Making smartphones is an emissions-laden process

A brand-new smartphone generates an average of 85 kilograms in emissions in its first year of use. Ninety-five percent of this comes from manufacturing processes, including the extraction of raw materials and shipping. Exactly how much CO2e this releases depends on several factors, mainly:

- **How much recycled material is used.**[7] Reusing materials implies a reduction in carbon-intensive mining. Tin can be reused for circuit boards, cobalt for batteries, and aluminum for enclosures.[8] Technology now also exists to recycle rare-earth elements, which go into components such as speakers and actuators; up until a few years ago, extracting rare-earth elements from these components was considered commercially unviable due to their small size.[9]

- **How energy-efficient manufacturers' facilities are.** The production of the integrated circuits used in smartphones consumes significant amounts of energy. For example, up to 30% of a semiconductor fabrication plant's operational costs comes from the energy needed to maintain constant temperature and humidity.[10]

- **How heavily the manufacturing ecosystem relies on renewable energy.** This relates to owned facilities as well as to third parties to which vendors outsource manufacturing. Vendors may need to convince and assist their outsourced supply chain to migrate to renewable energy sources such as wind, solar, and hydro.[11]

After it is manufactured, a smartphone generates an average of 8 kilograms of emissions from usage during its working life, which is most commonly between two and five years.[12] At the end of that time, its end-of-life CO2e emissions are determined partially by the ease with which its components can be recycled.[13]

Because manufacturing accounts for almost all of a smartphone's carbon footprint, the single biggest factor that could reduce a smartphone's carbon footprint is to extend its expected lifetime.[14] There could still be just as many smartphones in use; what would change is that each smartphone would be used for longer, regardless of the number of individual owners of each smartphone during its lifetime. Even accounting for the CO2e emissions resulting from refurbishing and shipping a used phone, prolonged ownership, whether by the original owner or a series of owners, provides a clear-cut benefit.

Several trends point to the likelihood that smartphone lifetimes will likely indeed become longer in the medium term:

Smartphones are becoming physically tougher, reducing the need for unplanned replacement. Screen breakages and water damage have historically been common causes for a phone to be written off. But screens can now cope with multiple short drops, and resilience to being dropped is a point of differentiation.[15] And flagship-model smartphones, whose higher sales price enables the use of higher quality, are becoming more resistant to water damage every year. The latest flagships can now survive immersion at up to 6 meters' depth for half an hour.[16]

Software support for smartphones is being offered for longer. The period over which a vendor maintains software support has a strong impact on the resale value of a device: It is hard to sell a phone that is unlikely to be useful. To enable older phones to work well, smartphone vendors create or source specific versions of each operating system (OS) for each model of phone. Such an OS refresh may well include design changes that make an existing phone "look" new; updated code can

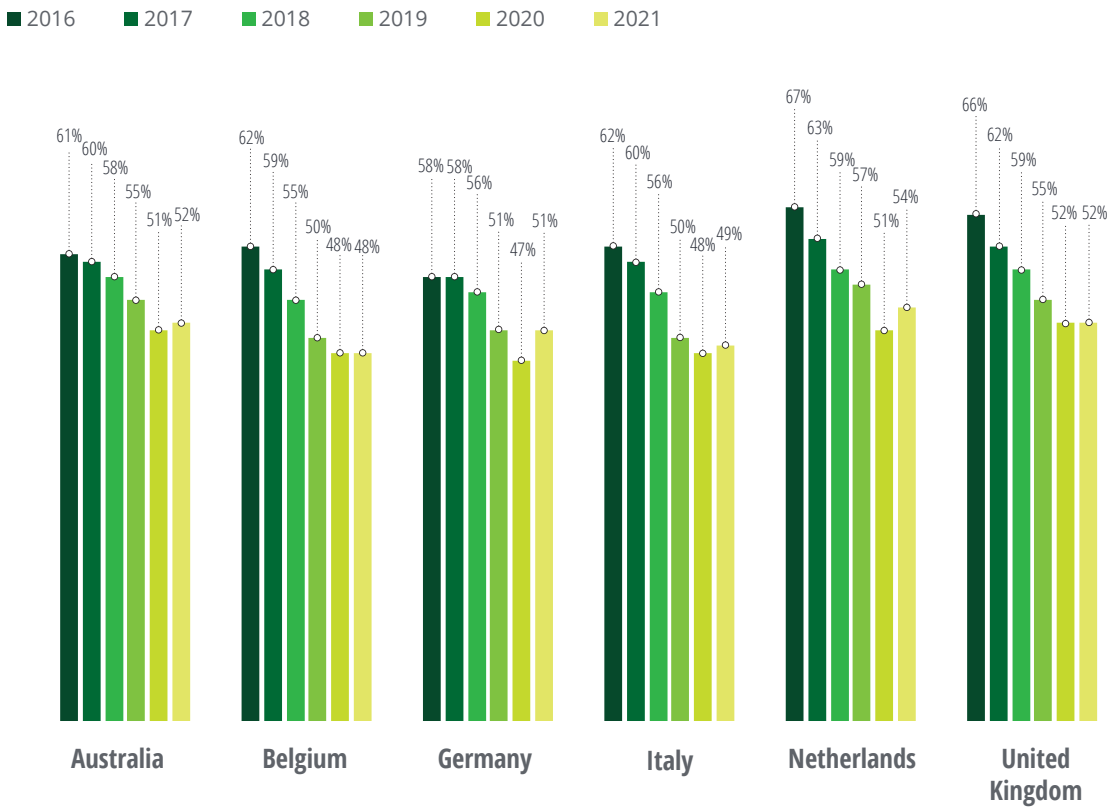
also make existing processes flow better and consume less energy. Vendors also need to provide regular security updates to patch vulnerabilities. As of the start of 2022, the length of this kind of support for a given smartphone's OS is likely to vary between three and five years, depending on vendor, but we expect that by 2025, competitive pressures may have made five years commonplace for most flagship models.[17] In the EU, all smartphone vendors may need to provide security updates for five years beginning in 2023.[18]

Consumers are keeping phones for longer. The average ownership time for smartphones has steadily been lengthening in developed markets. Figure 1 shows that between 2016 and 2021, there was a decline in the proportion of respondents whose smartphones had been bought in the prior 18 months (the trend reversed in markets in 2021, which we attribute to forced savings on services as a result of the pandemic leading to greater spend on devices). Over the same period and in the same markets, the percentage of smartphones

FIGURE 1

Consumers are keeping their smartphones for longer

Proportion of smartphone owners who had purchased their phone in the prior 18 months, 2016–2021



Source: Deloitte Digital Consumer Trends, May–June 2016, May–June 2017, June 2018, May–June 2019, May 2020, June–August 2021.

purchased over 3.5 years ago doubled on average from 5% to 10%.[19]

Flagship phones now commonly cost US$1,000 or more. One powerful motive to keep a smartphone for longer has been the high cost of new devices, which may require three years versus the former typical two years to pay off fully. In 2017, the idea of a US$1,000 smartphone raised skeptical eyebrows. But just one year later, that price point had become commonplace for flagships, with most vendors offering multiple smartphones at US$1,000 or more.[20]

The global market for refurbished and handed-down phones is growing. The higher a phone's nominal resale value, the more likely it is to be traded in. A US$1,000 phone could retain half its value after the first year, providing the minority of smartphone users who swap out premium phones annually a strong incentive to trade them in.[21] Companies also have an incentive to refurbish: a one-year-old, pristinely refurbished phone may retail for 80% of the price of a brand-new one. A four-year-old premium phone may be unwanted in wealthier markets but be in significant demand in emerging ones. Premium phones are also likely to be more water and dust resistant and use better quality glass than lower-priced phones.[22] Indeed, the refurbished smartphone market is expected to grow annually at 11.2% per year through 2024, at which point it will be worth US$65 billion and comprise 352 million units.[23]

THE BOTTOM LINE

Longer smartphone lifetimes could reshape how the smartphone industry generates revenues and profits.

Smartphone vendors could offer higher-priced devices to balance out a fall in the quantity of devices sold, and they may be able to charge a green premium among consumers who favor vendors that have more sustainable approaches. However, vendors should also think about how to grow revenue from sources other than device sales, which could include:

- Media services and applications stores
- Online storage—demand for which will grow steadily over time as photos and videos accumulate
- Sales of complementary hardware with lower emissions per unit than smartphones (such as Bluetooth headphones, whose sales are forecast to grow by 35% in 2022)[24]
- Commissions on insurance premiums[25] and financial products related to the purchase or lease of smartphones

Over time, smartphone buyers may differentiate their purchases on the basis of a vendor's green credentials. But this is unlikely in the short term. According to a Deloitte multinational study, fielded in mid-2021, use of recycled materials was the least important factor when choosing a smartphone in 10 out of 13 countries.[26]

For carriers, which have long generated sales by bundling smartphones with new multiyear contracts, a reduction in the sale of new phones could be punitive. But mobile operators could also bundle contracts with refurbished devices, as well as sell ancillary services, such as insurance. Furthermore, many operators already have a significant proportion of customers on SIM-only tariffs, which only include airtime and are not linked with sales of new smartphones.

For the smartphone industry as for others, reaching decarbonization targets often requires companies to change the way they do business. However, the ultimate payoff can be much bigger than the smartphone industry alone. Initiatives taken by the smartphone industry are likely to influence emissions reductions in other device categories. Innovations that reduce emissions for smartphones, such as using recycled materials, could be applied by the same vendor to other devices, such as tablets, in its portfolio. And efforts to prolong smartphone battery life by reducing energy consumption could be applied to reduce energy consumption in other devices, from laptops or smart speakers that historically have had less need for energy-efficient design due to being plugged into a wall socket.[27] The sum of all of these reductions may add up to a figure far greater than what smartphones alone produce—and even if it doesn't, every little bit counts.[28]

Endnotes

1. Gartner, “Gartner forecasts global devices installed base to reach 6.2 billion units in 2021,” press release, April 1, 2021.
2. We have used a range of publicly available information to arrive at this prediction. For CO2e emissions per device and the split by production, use, transport, end-of-life procession, see: Apple, *iPhone 12 product environmental report*, October 13, 2020; Huawei, “Product environmental information,” accessed October 6, 2021; Google, *Pixel 5 product environmental report*, accessed October 6, 2021. For 2022 smartphone shipments information, see: International Data Corporation, “Smartphone shipments to grow 5.5% in 2021 driven by strong 5G push and pent-up demand, according to IDC,” March 10, 2021; for the 2022 installed base of smartphones, see: Gartner, Gartner, “Gartner forecasts global devices installed base to reach 6.2 billion units in 2021.” *TMT Predictions 2022* is an independent publication and has not been authorized, sponsored, or otherwise approved by Apple Inc.
3. The global annual average per capita is 4.6 metric tons. Some developed markets have a much greater carbon footprint per capita. For example, the US annual average per capita is 15.5 metric tons: The World Bank, “CO2 emissions (metric tons per capita),” accessed October 6, 2021.
4. International Data Corporation, “Smartphone shipments to grow 5.5% in 2021 driven by strong 5G push and pent-up demand, according to IDC.”
5. This percentage is based on data for Apple iPhone 12, see: Apple, *iPhone 12 product environmental report*. *TMT Predictions 2022* is an independent publication and has not been authorized, sponsored, or otherwise approved by Apple Inc.
6. These proportions are derived from publicly available sources on emissions per device; as emissions vary by smartphone model, we have used vendor market share data to estimate emissions across the installed base of devices. Sources we have used include the following: Apple, *iPhone 12 product environmental report;* Huawei, “Product environmental information”; Google, *Pixel 5 product environmental report. TMT Predictions 2022* is an independent publication and has not been authorized, sponsored, or otherwise approved by Apple Inc.
7. Recycling avoids carbon-intensive processes like mining. Kimberly Botwright and James Pennington, “Will your next phone be made from recycled materials? These 6 tech giants are working on it,” World Economic Forum, September 24, 2020.
8. Apple’s iPhone 12 uses recycled metals and rare-earth elements. Samsung plans to use recycled materials in all of its phones by 2025. Apple, *iPhone 12 product environmental report*; Samsung Newsroom, “Samsung Electronics announces sustainability vision for mobile: Galaxy for the planet,” August 11, 2021.
9. Stephen Nellis, “Apple taps recycled rare earth elements for iPhone parts,” Reuters, September 18, 2019; Yu Kun-ha, “3 Korean PEFs take 20% stake in Australian rare earth mining project for US$250 mil.,” *Business Korea*, July 21, 2021.
10. Srilatha, “Examining the carbon footprint of devices,” Microsoft, November 23, 2020; Steve Chen, Apoorv Gautam, and Florian Weig, “Bringing energy efficiency to the fab,” McKinsey & Company, accessed October 6, 2021; Shih-Cheng Hu et al., “Energy savings approaches for high-tech manufacturing factories,” *Case Studies in Thermal Engineering* 17, no. 100569 (2020).
11. Apple has announced that 100 of their manufacturing partners are moving to 100% renewable energy. Once this is complete, this will remove 15 million metric tons of CO2e annually. Apple, “Apple powers ahead in new renewable energy solutions with over 110 suppliers,” press release, March 31, 2021. *TMT Predictions 2022* is an independent publication and has not been authorized, sponsored, or otherwise approved by Apple Inc.

12. Deloitte estimate based on industry data.

13. Some vendors have designed processes to enable the dismantling of their devices such that core materials can be reused in new devices. Apple, "Apple expands global recycling programs," press release, April 18, 2019.

14. There would also be an impact on e-waste, with fewer discarded smartphones ending up partially or wholly in landfills. For more information on e-waste, see: Globalewaste.org, "The global e-waste statistics partnership," accessed October 6, 2021.

15. Sean Hollister, "Corning's new Gorilla Glass Victus could let your phone survive a six-foot drop, plus scratch resistance, "*Verge*, July 23, 2020; Vanessa Hand Orellana," iPhone 12 drop test: The ceramic shield screen went above and beyond," CNET, March 5, 2021.

16. Adam Ismail and Jordan Palmer, "The best waterproof phones in 2021," Tom's Guide, September 21, 2021; Chris Velazco, "The Engadget guide to the best midrange smartphones," Engadget, June 15, 2020.

17. In December 2020, it was announced that Google and Qualcomm were working together to make it easier for smartphones with the Android operating system, most of which are based on Qualcomm chipsets, to have four years of support. Abner Li, "Google, Qualcomm lay the technical groundwork for 4 years of Android updates," 9to5Google, December 16, 2020; Google Pixel phones have historically had commitments of three years' worth of software updates from when the device first became available: Google, "Pixel phone help," accessed October 6, 2021; Apple provides support for at least five years and for some models, even longer. Karen Haslam, "How long does Apple support iPhones?," *Macworld*, July 15, 2021; Samsung provides five years of security update support for enterprise models: Samsung Newsroom, "Samsung raises the bar for mobile experience innovation committing to three generations of Android OS upgrades," August 18, 2020.

18. Christian Wölbert, "EU plans energy label and strict environmental rules for smartphones and tablets," *Heise*, August 25, 2021.

19. Deloitte, Deloitte Digital Consumer Trends and Deloitte Global Mobile Consumer Survey, May-Jun 2016, May-Jun 2017, Jun 2018, May-Jun 2019, May 2020, Jun-Jul 2021, Jun-Aug 2021. Percentage increase is based on an average of the results for Australia, Belgium, Germany, Italy, Netherlands, and United Kingdom.

20. Vlad Savov, "In less than a year, the $1,000 phone has become entirely normal," *Verge*, August 21, 2018.

21. Vodafone UK has noted that it now resells 94% of phones that are traded in. Alan Lu, "Reducing e-waste: How your old smartphone can be recycled," Vodafone, October 27, 2020.

22. Andrew Heinzman, "Why you don't need an expensive smartphone anymore," Review Geek, January 18, 2021.

23. The refurbished smartphone market is forecast by IDC to grow from 225.5 million units in 2020 to 351.6 million units in 2025. International Data Corporation, "IDC forecasts worldwide market for used smartphones to reach 351.6 million units with a market value of $65 billion in 2024," January 7, 2021.

24. Neil Mawston, "Bluetooth headphone revenues to grow 35% in 2022," Strategy Analytics, May 13, 2021.

25. The market for mobile phone insurance is forecast at $29.5 billion globally in 2022, with a base value of $23.3 billion in 2020, and a CAGR of 12.6%. Grand View Research, *Mobile phone insurance market size, share & trends analysis report by coverage, by phone type, by region, and segment forecasts, 2021–2028*, April 2021.

26. Based on responses from Deloitte's multinational Digital Consumer Trends survey, fielded in 2021.

27. Laptop vendors have started to offer devices based on chip architectures that are more power efficient, which were formerly only used in smartphones and tablets. John Loeffler, "How battery life could be the major mobile computing fight of 2021," TechRadar, December 31, 2020.

28. There are multiple other ways in which emissions for smartphones may be reduced. One would be to have battery technology that could tolerate far more recharges than that possible with the current formulation for which 500 recharges is considered a typical lifetime before performance degrades. New battery technologies that offer sufficiently better performance to warrant a wholesale industry shift is challenging—and would likely require, for example, the replacement of billions of chargers. There are lots of examples of innovations in battery tech, and one such example is here: IANS, "New technology to extend battery life in smartphones, electric cars," *Bridge Chronicle*, November 3, 2020.

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